(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 287 680 A1

(12) # EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(21) Application number: 87906783.3

(22) Date of filing: 16.10.87

Data of the international application taken as a basis:

(86) International application number: PCT/JP87/00794

(87) International publication number: WO88/02669 (21.04.88 88/09)

(51) Int. Cl.³: B 21 B 37/00
B 21 C 51/00, G 01 B 7/04

(30) Priority: 17.10.86 JP 248216/86

(43) Date of publication of application: 26.10.88 Bulletin 88/43

(84) Designated Contracting States: DE FR GB IT NL

(71) Applicant: NIPPON STEEL CORPORATION
6-3 Otemachi 2-chome Chiyoda-ku
Tokyo 100(JP)

(72) Inventor: YAMAOKA, Masayoshi Nippon Steel Corp. Yawata Works
1-1-1, Edamitsu Yahatahigashi-ku
Kitakyushu-shi, Fukuoka 805(JP)

(72) Inventor: TSUTSUI, Kiyomi Nippon Steel Corp. Yawata Works
1-1-1, Edamitsu Yahatahigashi-ku
Kitakyushu-shi, Fukuoka 805(JP)

(72) Inventor: INOUE, Tadashi
1227, Shimozakai
Noogata-shi Fukuoka 822(JP)

(72) Inventor: TAKAHASHI, Toyoki
9-22, Hiyoshidai 3-chome Yahatanishi-ku
Kitakyushu-shi Fukuoka 807(JP)

(74) Representative: Vossius & Partner
Siebertstrasse 4 P.O. Box 86 07 67
D-8000 München 86(DE)

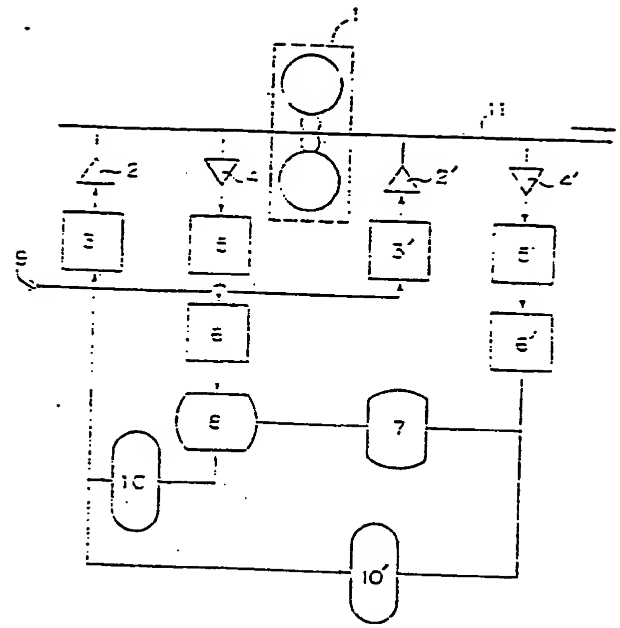
(54) **APPARATUS FOR MEASURING THE DRAFT OF A ROLLED STEEL.**

(57) An apparatus for finding the draft of a rolled steel by measuring the moving speed of magnetic marks attached by magnetization to the strips on the input and output sides of a rolling mill, wherein the rise of a signal is used as a timing for detecting the magnetic mark on the input side, the signal being obtained by the logical product of a detecting signal of the input side and a gate pulse that opens with a magnetic mark detecting signal of the output side and that closes after an optimum period of time has passed and wherein the comparator level of a detector is automatically changed depending upon the magnitude of the magnetic mark that is stored, in order to improve the S/N of magnetic mark signals of the input side and to reduce the erroneous detection as much as possible.

EP 0 287 680 A1

Croydon Printing Company Ltd

Fig. 3



DESCRIPTION

TITLE OF THE INVENTION

Apparatus for Measuring Reduction Ratio of Rolled Material

TECHNICAL FIELD

The present invention relates to a non-contact type apparatus for the measurement of a reduction ratio during the rolling of a steel sheet or the like.

BACKGROUND ART

The reduction ratio of a rolled material can be computed from the speed of movement of the material before and after the rolling. As a means for measuring the speeds of movement of the material before and after the rolling, a contact type apparatus was often adopted in which measuring rolls or other measuring devices were brought in contact with strip coils on the inlet and outlet sides. However, recently, since the rolling speed has greatly increased and the necessity for a wet rolling using water or oil because of high-pressure operation has increased, the problem of a reduction of the measurement precision due to slips page has become serious, and therefore, a non-contact type apparatus in which magnetic marks are formed on the inlet and outlet sides and these marks are inspected in a non-contact manner has been developed. Apparatuses of this type are disclosed in Japanese Examined Utility Model No. 43-29667 and Japanese Unexamined Patent Publication No. 55-94711.

Japanese Examined Utility Model Publication No. 43-29667 discloses a basic apparatus in which the speed of movement of a magnetic mark on a material is measured before or after rolling. However, this apparatus is defective in that, when the material is moved at a high speed, a delay in operation occurs in either a magnetizer or a detector and an offset error inherent to the rolling operation cannot be avoided. As a means for

overcoming this defect, the applicant of the instant application developed and proposed the measurement apparatus disclosed in Japanese Unexamined Patent Publication No. 55-94711. However, when this apparatus was put to practical use, it was found that this apparatus still leaves problems to be solved. Namely, in the actual rolling operation, since the material has a property such that the hardness on the inlet side is lower than the hardness on the outlet side, the intensity of the magnetic mark is proportionally reduced, and an erroneous operation is readily caused by a noise, especially in the case of a soft material such as low-carbon steel for use in deep drawing, for which the demand has recently increased. Moreover, since the material on the inlet side is softer than on the outlet side and local deformation is readily caused by the winding motion of the roll through the travel, the gap between the material and the detector is changed, to generate noise and worsen the S/N ratio, and in this case, if the comparison level of the detector is fixed, the error in the detection is enlarged.

It is an object of the present invention to provide a measurement apparatus in which the problems of the apparatus disclosed in Japanese Unexamined Patent Publication No. 55-94711 are solved and the reduction ratio can be precisely measured irrespective of the kind of the material to be rolled.

DISCLOSURE OF THE INVENTION

The object of the present invention is attained by an apparatus for measuring the reduction ratio of a rolled material, which comprises magnetizers disposed on the inlet and outlet sides of a rolling mill to form a magnetic mark on a material to be rolled and detectors coupled with the magnetizers and spaced from the corresponding magnetizers by a certain distance, wherein the reduction ratio is computed from the speed of movement of the material on the inlet and outlet sides, said

apparatus being characterized in that the apparatus further comprises a gate which is opened by a detection signal from the detector on the outlet side and is closed after an optimum time determined by the line speed and the set range of the reduction ratio, the rising of the signal after sampling of the logical product of the gate signal and the detection signal on the inlet side is adopted as the timing for detection of the magnetic mark on the inlet side, and between the respective coupled magnetizers and detectors on the inlet and outlet sides, the magnitudes of the magnetic marks are stored and during the non-magnetization period for computation of the reduction ratio, the comparison levels of the detectors are automatically changed.

From the viewpoint of controllability of the rolling mill. Preferably the time interval for the output of the reduction ratio values is constant and a maximum number of samples is collected under this condition. In the apparatus of the present invention, therefore, a method is adopted in which the present line speed is read in a CPU, a maximum number of samples that can be collected during the output time interval is computed, and the measurement precision and controllability of the rolling mill are reconciled.

The present invention will now be described with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1. is a diagram illustrating the states of detection pulses in the conventional apparatus and the apparatus of the present invention; Fig. 2 is a diagram illustrating the relationship between the comparison level and the magnetic mark in the conventional apparatus; Figs. 3 and 4 are block diagram illustrating the structures of embodiments of the present invention; and, Fig. 5 is a flow chart showing the operation of the CPU in an embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The principle of the present invention will now be described with reference to Fig. 1, while comparing the present invention with the conventional technique.

The first characteristic feature of the present invention is that a worsening of the S/N ratio of the magnetic mark signal on the inlet side, as shown in Fig. 1-(a) or an erroneous detection, is reduced as much as possible. Namely, because of the irregular and rough surface of a material to be rolled, the magnetic mark signal on the inlet side ordinarily has a complicated wave form including many peaks and troughs, as shown in Fig. 1-(a). If this signal is detected above a certain comparison level which refers to a standard level to be compared with the level of the detected signal a plurality of detection pulses are obtained, as shown in Fig. 1-(b), resulting in an erroneous detection.

On the other hand, the magnetic mark signal on the outlet side has a large absolute value and a simple wave form, as shown in Fig. 1-(c), because the material has been unformly surface-processed and hardened and the surface has been smoothened. Accordingly, a detection pulse obtained by detecting this signal above a certain comparison level has one rising, as shown in Fig. 1-(d), and no erroneous detection is caused. In the apparatus of the present invention, since the distance between the coupled magnetizer and detector on the inlet side is equal to the distance between the coupled magnetizer and detector on the outlet side, if magnetization is effected simultaneously on both the inlet and outlet sides, the magnetic mark on the outlet side always arrives earlier at the detector. Accordingly, in the present invention, by forming a gate pulse which is opened by the magnetic mark detection signal [Fig. 1-(d)] and closed after the lapse of a time determined by the line speed and the set range of the reduction ratio, that is, a gate pulse as shown in Fig. 1-(e), an erroneous detection pulse in the uncorrected detection pulse

on the inlet side, as shown in Fig. 1-(b), is removed. The pulse time Tpu of the gate pulse shown in Fig. 1-(e) is set, for example, by the equation of Tpu = L x 1/v x 0.1 (sec), in which L stands for the distance (m) between the magnetizer and detector and V stands for the line speed (m/sec), if the reduction ratio is about 10%.

Note, where the reduction ratio is very low and the detection timing [Pu in Fig. 1-(c)] of the magnetic mark on the outlet side is not sufficiently earlier than the detection timing of the magnetic mark on the inlet side, there is sometimes adopted a method in which the gate is opened at the time when the magnetic mark signal on the outlet side rises to the comparison level, that is, at the timing Pd shown in Fig. 1-(c).

If the gate is opened at the timing Pd, the rising of the gate pulse is Gd in Fig. 1-(e), and if the expansion of the magnetic mark at this time is $\pm d$ (m), the pulse time Tpd is expressed by the following equation:

$$\text{Pulse time Tpd} = \text{Tpu} + d/v \text{ (sec)}$$

If the detection signal on the inlet side is thus passed through the gate which is opened at the timing Pd or Pu to cause the gate pulse to rise at Gd or Gu and the logical product is taken, a signal as shown in Fig. 1-(f) is obtained, and the S/N ratio is improved and the risk of erroneous detection is moderated. According to the conventional technique, the measurement is impossible with respect to a soft material having a temper smaller than 4, but according to the apparatus of the present invention, the measurement is possible with respect to a soft material having a temper as small as 2.5 (corresponding to a Rockwell hardness H_R of about 55).

The second characteristic feature of the present invention is that the comparison level of the detector is adjusted at each time. This feature will now be described in detail. In a continuous annealing-rolling

line, in general, a method is adopted in which various products having different surface hardnesses are prepared, and a plurality of materials to be rolled are joined together by welding and fed to a rolling mill. It is known that the intensity of the magnetic mark is greatly changed according to the quality and hardness of the material to be rolled. Accordingly, where the comparison level of the detector is always kept constant, if the comparison level is a value appropriate to a magnetic mark of a certain intensity as shown in Fig. 2-(a), no problem arises, but if the intensity of the magnetic mark is changed as shown in Fig. 2-(b), an erroneous pulse is generated, and in the state shown in Fig. 2-(c), a detection pulse is not generated. According to the present invention, the comparison level is appropriately adjusted according to the intensity of the magnetic mark to eliminate this deficiency. As a means for removing the deficiency due to the change of the intensity of the magnetic mark, there can be considered a method in which the comparison level is appropriately changed based on a material quality signal received from a host computer. However, since the material quality signal is a target value for the product and is a generic value over the entire length of one product, in practice a local change cannot be detected, and the number of interface signals of the host computer is increased and the operation becomes complicated.

In the present invention, a method is adopted in which the peak values of a raw signal grasped between the magnetizer and detector for the preceding computation of the reduction ratio, that is, the magnitudes of the magnetic mark, are averaged according to the sample number by the computer and the comparison level is set, for example, at 2/3 of the obtained peak value. Therefore, according to the present invention, the comparison level corresponding to the practical intensity of the

magnetic mark is always appropriately set. Note, when the intensity of the magnetic mark on the inlet side is sampled, in order to know the true magnitude of the detection pulse, the peak value is sampled after passage through the gate shown in Fig. 1-(e).

Embodiments of the apparatus of the present invention will now be described in detail with reference to the accompanying drawings.

As shown in Fig. 3, magnetizing heads 2 and 2' and magnetizing units 3 and 3' are arranged on the inlet and outlet sides, and magnetic sensors 4 and 4' are arranged equidistantly downstream (in the direction of advance) from the magnetizing heads 2 and 2'. Amplifiers 5 and 5' and comparators 6 and 6' are connected to the magnetic sensors 4 and 4'.

In this apparatus, the magnetizing heads 2 and 2' are simultaneously actuated by a magnetizing instruction indicated by reference numeral 9 in the drawings to form a mark on a material 11 to be rolled. The magnetic mark is detected by the magnetic sensors 4 and 4' and detection pulses are obtained at the comparators 6 and 6'. As pointed out hereinbefore, the detection pulse of the comparator 6' has a high reliability but there is a great risk that the comparator 6 includes an erroneous detection pulse. Accordingly, the detection pulse of the comparator 6' is introduced into a gate generator 7 to generate a gate signal, an "AND" of the signal of a gate 8 and the detection pulse of the comparator 6 is taken, and this signal is fed to a counter 10 on the inlet side and is used as a stop pulse for the counter 10 on the inlet side. Namely, the counter 10 on the inlet side which has begun counting on receipt of the magnetizing instruction 9 is stopped by the signal which has passed through the gate 8. A counter 10' on the outlet side which has begun counting on receipt of the magnetizing instruction 9 is stopped by the signal from the comparator 8' on the outlet side. The reduction

ratio of the material 11 is computed from the elapsing times read by the counters 10 and 10' on the inlet and outlet sides.

An embodiment of the means for adjusting the comparison level of the detector will now be described with reference to Fig. 4. Referring to Fig. 4, of the raw signals detected by the magnetic sensors 4 and 4' on the inlet and outlet sides and amplified by the amplifiers 5 and 5', the raw signal on the inlet side is passed through the gate 8 started by the detection pulse on the outlet side and sampled by an A/D converter 12 while the raw signal on the outlet side is directly sampled by the A/D converter, and the peak values are introduced into a computer, for example, sub-CPU 13, and are averaged according to the sample numbers on the inlet and outlet sides, respectively. Digital values corresponding to, for example, 2/3 of the respective mean values are computed by this sub-CPU 13 and are supplied to the comparators 6 and 6' on the inlet and outlet sides, respectively, as analog values of the comparison levels through a D/A converter 14. Of course, this conversion of the comparison levels is carried out during the operation of main CPU 15 for computation of the reduction ratio but is not carried out during the period of magnetization and detection for sampling of computation data, so that the operation for computation of the reduction ratio is not disturbed.

In the present embodiment, the line speed represented by reference numeral 16 is converted by the A/D converter 12 and is then taken into the sub-computer 13, and after simple computation, a sample number 17 optimal to the present line speed is interfaced in the main CPU 15, whereby the measurement precision and the controllability are reconciled in the apparatus. The line speed 16 can be easily measured in the apparatus from the distance between the magnetizer and detector and the elapsing time between the magnetization and the

detection.

The operations of main CPU and sub-CPU in the embodiment of the present invention is illustrated in Fig. 5. By the operations shown in this flow chart, the main CPU shown in Fig. 4 controls the magnetization and detection, and the count values of the counters 10 and 10' are taken in the main CPU and averaged according to the sample number 17. After the precision is thus increased, the result of computation of the reduction ratio is put out as the output 18.

INDUSTRIAL APPLICABILITY

As is apparent from the foregoing description, according to the apparatus of the present invention, the defect of the conventional apparatus, where the S/N ratio is degraded on the inlet side because of the material or hardness of a material to be rolled or the local deformation on the surface and erroneous detection is readily caused, can be eliminated, an erroneous detection can be prevented and the detection level can be adjusted at each time according to the intensity of the present magnetic mark of the material to be rolled. Accordingly, an erroneous detection is not caused even if the quality or hardness of the material to be rolled is changed. Furthermore, although the measurement is impossible with respect to a soft material having a temper smaller than 4 according to the conventional technique, the measurement is possible even with respect to such a soft material as a steel sheet having a temper of 2.5, which is used for draw-forming of a juice can or the like, according to the present invention.

Table of Reference Numerals

1: rolling mill
2, 2': magnetizing heads on inlet and outlet sides
3, 3': magnetizing units on inlet and outlet sides
4, 4': magnetic sensors on inlet and outlet sides
5, 5': amplifiers on inlet and outlet sides
6, 6': comparators on inlet and outlet sides
7: gate generator
8: gate
10, 10': counters on inlet and outlet sides
11: material to be rolled
13: sub-CPU
15: main CPU
18: output of result of computation of reduction ratio

CLAIM

An apparatus for measuring the reduction ratio of a rolled material from moving speeds of a material to be rolled on the inlet and outlet sides of a rolling mill, which comprises magnetizers disposed on the inlet and outlet sides to form a magnetic mark on the material to be rolled, detectors coupled with the magnetizers and spaced from the corresponding magnetizers by a certain distance, counters to be actuated by signals of the magnetizers and detectors, a gate connected between a comparator of the detector on the inlet side and the counter on the inlet side, and a gate generator connected to the outlet of a comparator of the detector on the outlet side and to the gate, wherein a gate signal generated from the gate generator is put into the gate, the logical product value of the gate signal and a detection signal on the inlet side is used as a stop signal for the detector on the outlet side, a signal from the comparator of the detector on the outlet side is used as a stop signal for the counter on the outlet side, elapsing times are read by the counters on the inlet and outlet sides from start signals put into the counters on the inlet and outlet sides based on magnetizing instructions to the magnetizers on the inlet and outlet sides and stop signals for the counters on the inlet and outlet sides to determine the speed of movement of the magnetic mark on the inlet and outlet sides, and the reduction ratio of the material is computed from said determined values.

Fig. 1

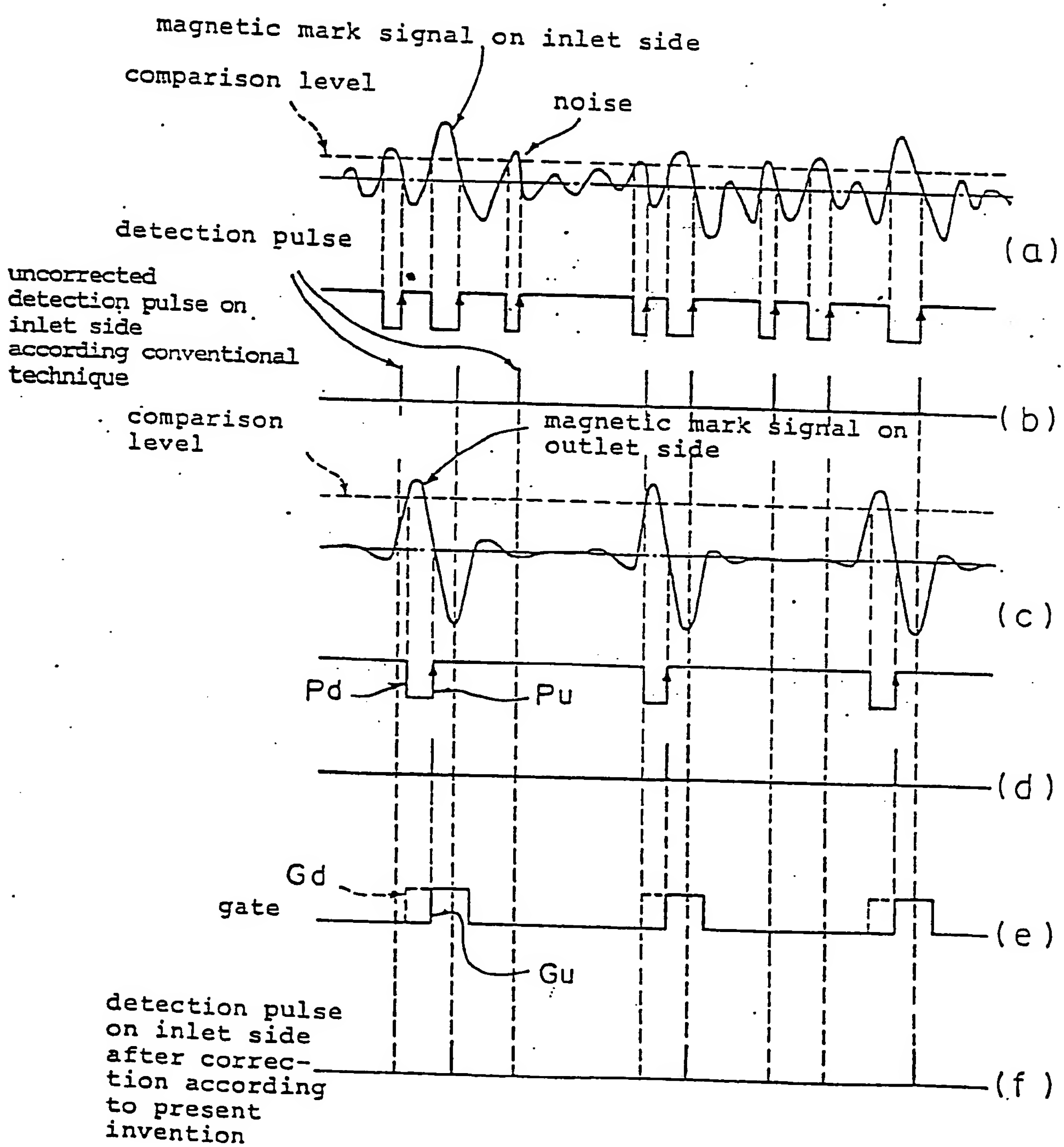

magnetic mark signal on inlet side
comparison level
noise
detection pulse
uncorrected detection pulse on inlet side according conventional technique
(a)
(b)
comparison level
magnetic mark signal on outlet side
(c)
Pd
Pu
(d)
Gd
gate
(e)
Gu
detection pulse on inlet side after correction according to present invention
(f)

Fig. 2

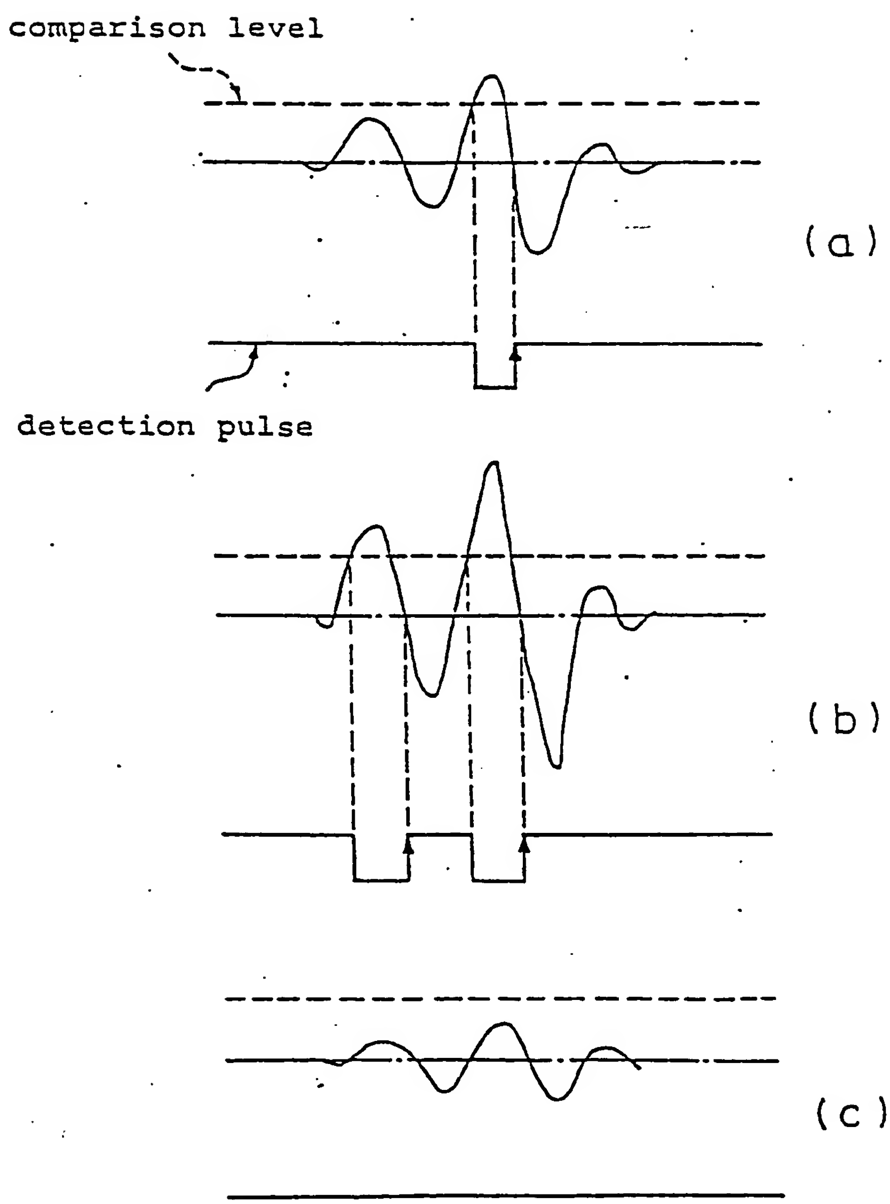


Fig. 3

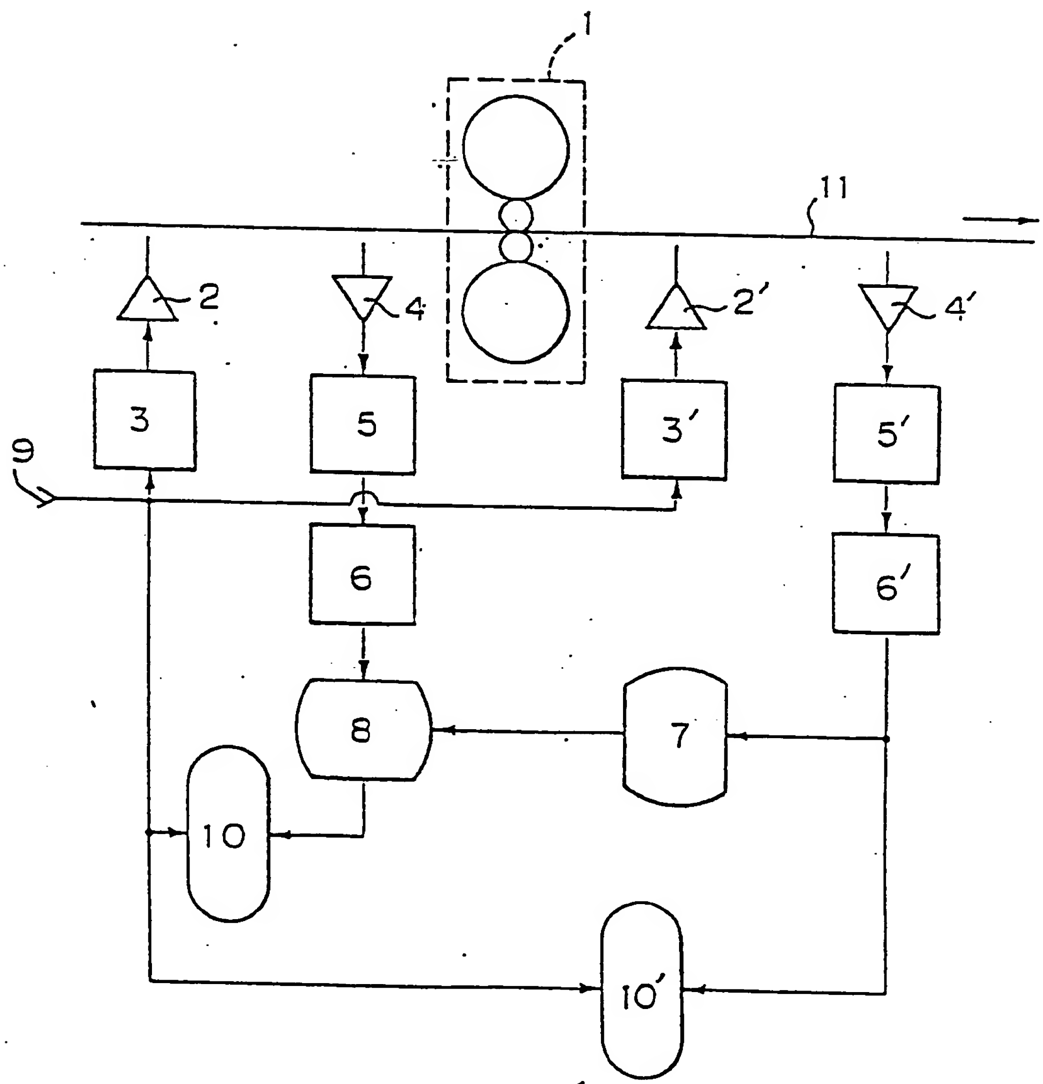


Fig. 4

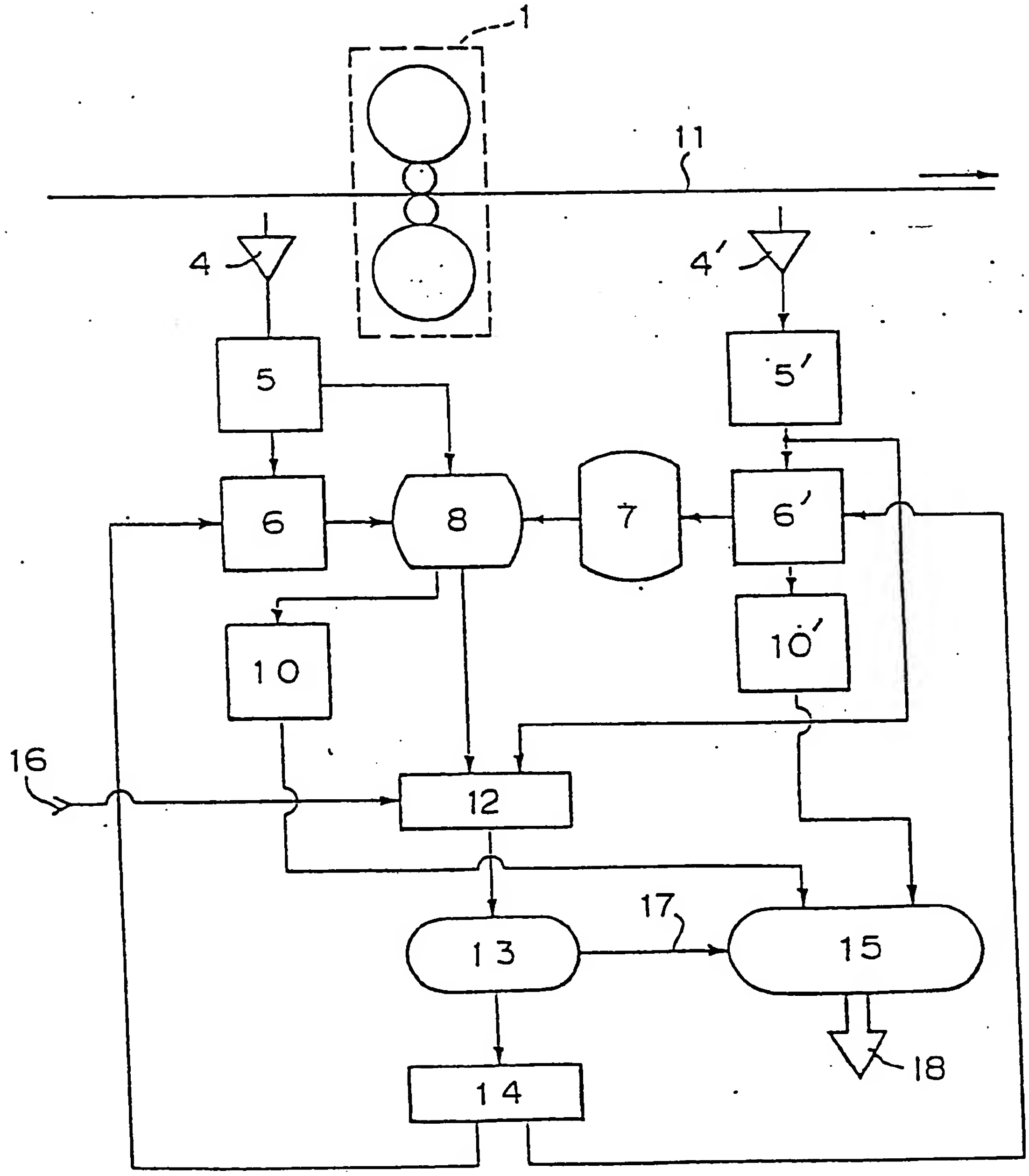
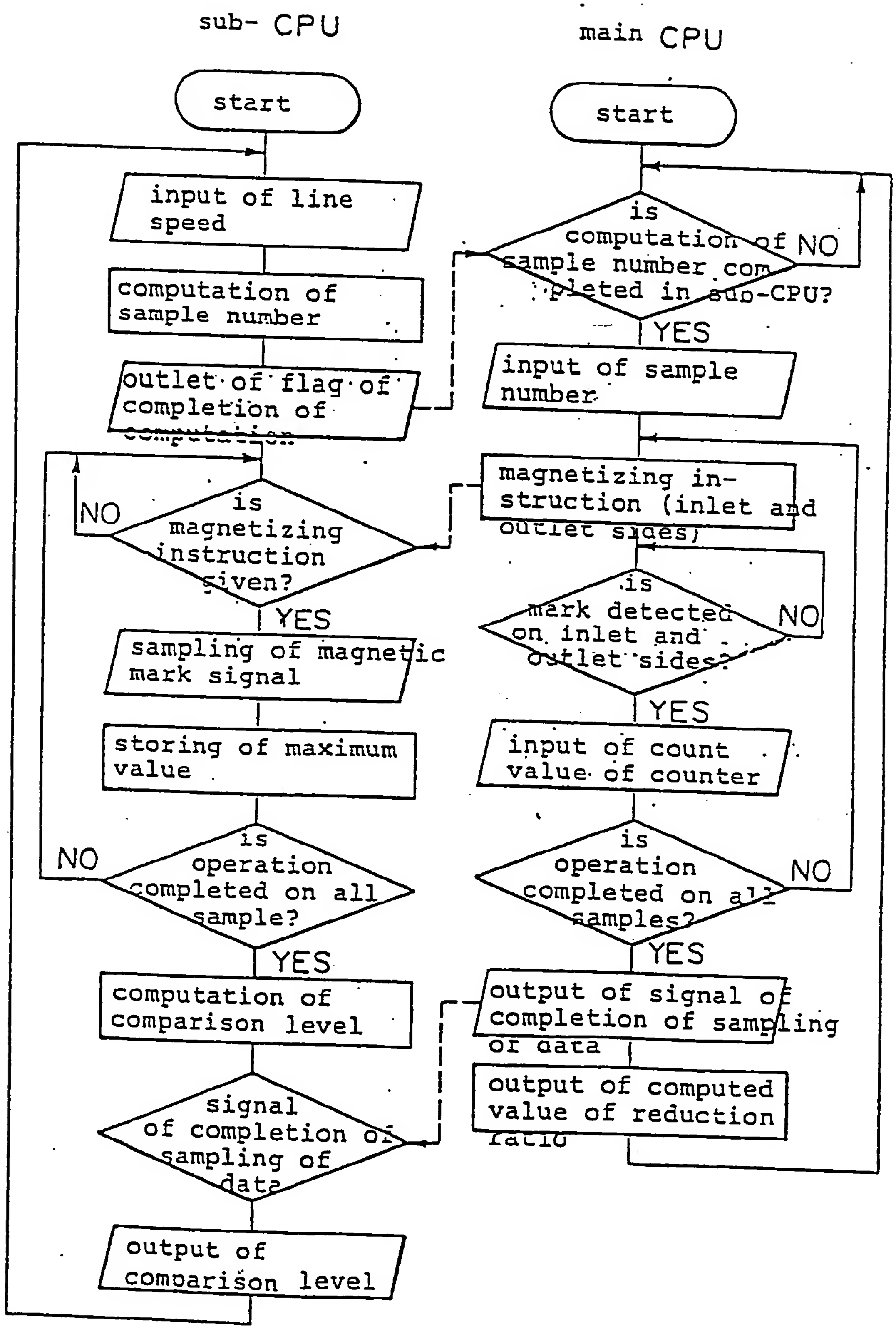


Fig. 5


sub- CPU
main CPU
start
input of line speed
computation of sample number
outlet of flag of completion of computation
is magnetizing instruction given?
NO
YES
sampling of magnetic mark signal
storing of maximum value
is operation completed on all sample?
NO
YES
computation of comparison level
signal of completion of sampling of data
output of comparison level
start
is computation of sample number completed in sub-CPU?
NO
YES
input of sample number
magnetizing instruction (inlet and outlet sides)
is mark detected on inlet and outlet sides?
NO
YES
input of count value of counter
is operation completed on all samples?
NO
YES
output of signal of completion of sampling of data
output of computed value of reduction ratio

INTERNATIONAL SEARCH REPORT

International Application No PCT/JP87/00794

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[4] B21B37/00, B21C51/00, G01B7/04

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	B21B37/00, B21C51/00, G01B7/04

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho	1922 - 1987
Kokai Jitsuyo Shinan Koho	1973 - 1987

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	JP, A, 55-94711 (Nippon Steel Corporation and one other) 18 July 1980 (18. 07. 80) (Family: none)	

* Special categories of cited documents: [15]
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
December 7, 1987 (07.12.87)	December 21, 1987 (21.12.87)
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Japanese Patent Office	

This Page Blank (USPTO)